Uranium

CAS No. 7440-61-1

General Information

Uranium is a silver-white, extremely dense, and weakly radioactive metal. It usually occurs as an inorganic compound with oxygen, chlorine, or fluorine. Uranium has many commercial uses, including its use in nuclear weapons, nuclear fuel, armor-piercing shells, in some ceramics, and as an aid in electron microscopy.

Human exposure to uranium occurs primarily in the workplace by inhaling dust and other small particles. Exposure to insoluble uranium oxides and uranium metal via inhalation results in retention of these forms of uranium in the lungs and other tissues with little excreted in the urine. Soluble forms of uranium salts are poorly absorbed in the gastrointestinal tract, but these small amounts can be reflected in urinary measurements. Some uranium can be absorbed from food and water, especially in areas where large amounts of uranium occur naturally.

Workplace air standards for external exposure to soluble and insoluble uranium compounds have been established (OSHA, ACGIH). Although older evaluations suggested the carcinogenicity of uranium among smokers, the U.S. EPA has withdrawn its classification; IARC and the National Toxicology Program (NTP) have no ratings,

Table 13. Uranium

Geometric mean and selected percentiles of urine concentrations (in µg/L) for the U.S. population aged 6 years and older, National Health and Nutrition Examination Survey, 1999-2000.

	Geometric mean (95% conf. interval)	Selected percentiles (95% confidence interval)						Sample size
		10th	25th	50th	75th	90th	95th	
Total, age 6 and older	.007 (.006-.008)	< LOD	< LOD	.007 (.006-.007)	.013 (.011-.015)	.026 (.022-.036)	.046 (.036-.054)	2464
Age group								
6-11 years	.008 (.006-.010)	< LOD	< LOD	.007 (.005-.007)	.013 (.009-.019)	.032 (.019-.046)	.046 (.032-.066)	340
12-19 years	.009 (.007-.010)	< LOD	< LOD	.009 (.008-.009)	.014 (.012-.017)	.025 (.021-.036)	.043 (.029-.066)	719
20 years and older	.007 (.006-.008)	< LOD	< LOD	.007 (.006-.007)	.012 (.010-.015)	.026 (.021-.036)	.045 (.035-.054)	1405
Gender								
Males	.008 (.007-.010)	< LOD	< LOD	.007 (.007-.009)	.015 (.012-.019)	.036 (.024-.044)	.053 (.043-.065)	1227
Females	.006 (.005-.007)	< LOD	< LOD	.006 (.005-.007)	.011 (.009-.013)	.023 (.017-.028)	.035 (.027-.049)	1237
Race/ethnicity								
Mexican Americans	.016 (.012-.022)	< LOD	< LOD	.015 (.011-.021)	.032 (.021-.049)	.059 (.040-.127)	.113 (.054-.298)	883
Non-Hispanic blacks	.008 (.007-.010)	< LOD	< LOD	.007 (.007-.010)	.013 (.011-.018)	.028 (.019-.040)	.049 (.031-.066)	568
Non-Hispanic whites	.007 (.006-.008)	< LOD	< LOD	.007 (.006-.007)	.012 (.009-.013)	.023 (.017-.030)	.041 (.028-.050)	822

< LOD means less than the limit of detection, which is 0.003 µg/L.

and CDC's National Institute for Occupational Safety and Health (NIOSH) classifies uranium as carcinogenic. Information about external exposure and health effects is available from the EPA IRIS Web site at http://www.epa.gov/iris and from ATSDR at http://www.atsdr.cdc.gov/toxprofiles.

Interpreting Urine Uranium Levels Reported in the Tables

Urine uranium levels were measured in a subsample of NHANES participants aged 6 years old and older. Subsamples were randomly selected within the specified age range to be a representative sample of the U.S. population. The analytical method measures only levels of the ^{238}U isotope and not levels of the ^{235}U isotope (higher in enriched uranium used as nuclear fuel). More than 99% of naturally occurring uranium is ^{238}U. Measuring uranium at these levels in urine is possible because of advances in analytical chemistry. Finding a measurable amount of uranium in urine does not mean that the level of uranium causes an adverse health effect.

Uranium may produce renal injury through its chemical effect. The U.S. Nuclear Regulatory Commission (NRC) has set an action level of 15 µg/L for uranium in urine to protect people who are occupationally exposed to uranium (NRC, 1978). Six workers in a depleted uranium program had concentrations of 0.110 to 45 µg/L (Ejnik et al., 2000). In people who drank well water with high

Table 14. Uranium (creatinine adjusted)

Geometric mean and selected percentiles of urine concentrations (in µg/gram of creatinine) for the U.S. population aged 6 years and older, National Health and Nutrition Examination Survey, 1999-2000.

	Geometric mean (95% conf. interval)	Selected percentiles (95% confidence interval)						Sample size
		10th	25th	50th	75th	90th	95th	
Total, age 6 and older	.007 (.006-.008)	< LOD	< LOD	.006 (.005-.007)	.011 (.010-.014)	.023 (.019-.027)	.034 (.026-.049)	2464
Age group								
6-11 years	.009 (.007-.010)	< LOD	< LOD	.008 (.006-.010)	.015 (.010-.020)	.026 (.020-.035)	.037 (.026-.077)	340
12-19 years	.006 (.005-.008)	< LOD	< LOD	.006 (.005-.007)	.010 (.008-.014)	.019 (.013-.025)	.030 (.021-.061)	719
20 years and older	.007 (.006-.007)	< LOD	< LOD	.006 (.005-.007)	.011 (.010-.014)	.023 (.019-.027)	.034 (.025-.050)	1405
Gender								
Males	.006 (.006-.007)	< LOD	< LOD	.006 (.005-.007)	.011 (.009-.014)	.021 (.017-.026)	.035 (.024-.054)	1227
Females	.007 (.006-.008)	< LOD	< LOD	.007 (.006-.008)	.012 (.010-.014)	.024 (.020-.027)	.034 (.025-.050)	1237
Race/ethnicity								
Mexican Americans	.015 (.011-.020)	< LOD	< LOD	.014 (.011-.019)	.029 (.019-.048)	.058 (.029-.127)	.100 (.044-.270)	883
Non-Hispanic blacks	.005 (.004-.006)	< LOD	< LOD	.005 (.004-.006)	.008 (.006-.011)	.017 (.011-.027)	.028 (.019-.039)	568
Non-Hispanic whites	.007 (.006-.008)	< LOD	< LOD	.006 (.005-.008)	.011 (.009-.013)	.020 (.015-.024)	.028 (.022-.050)	822

< LOD means less than the limit of detection (see previous table for LOD).

natural uranium concentrations, the median urinary concentration was 0.078 µg/L (ranging up to 5.65 µg/L), and a subtle effect of uranium on calcium and phosphate fractional clearance was indicated (within the normal range of these measures) but without effects on other biochemical or traditional markers of renal function (Kurttio et al., 2002). The urine uranium levels in Table 13 for the NHANES 1999-2000 subsample are well below any of the aforementioned levels.

Dang et al. (1993) and Karpas et al. (1996) reported values for small groups of normal individuals in a range similar to those values seen in this NHANES 1999-2000 subsample. In addition, other studies have demonstrated urinary uranium concentrations that are consistent with levels documented in this *Report*, in that the reported levels were below their respective detection limits (Hamilton et al., 1994; Komaromy-Hiller et al., 2000; Byrne et al., 1991). A previous non-random subsample from NHANES III (n = 499) showed concentrations that are essentially similar to those in Table 13 (Ting et al., 1999). In the current NHANES 1999-2000 subsample, geometric mean levels of the demographic groups were compared after adjustment for the covariates of race/ethnicity, age, gender, and urinary creatinine. Urinary uranium levels tended to be slightly higher for children aged 6-11 years than for people in the other two age groups. Urinary uranium levels in Mexican Americans were more than twice the levels of either non-Hispanic blacks or non-Hispanic whites. It is unknown whether differences between ages or races/ethnicities represent differences in exposure, body-size relationships, or metabolism.

Whether uranium at the levels reported here is cause for health concern is unknown; more research is needed. These urine uranium data provide physicians with a reference range so that they can determine whether people have been exposed to higher levels of uranium than those found in the general population. These data will also help scientists plan and conduct research about uranium exposure and health effects.